CUSTOMER NO.: 24737

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE HONORABLE BOARD OF PATENT APPEALS AND INTERFERENCES

In re application of J. WEESE	)	Examiner: D. CHU
	)	Art Unit: 2628
Serial No.: 10/535,292	)	
	)	Confirmation: 5985
Filed: May 17, 2005	)	
For: **METHOD AND APPARATUS FOR VISUALIZING A SEQUENCE OF VOLUME IMAGES**	)	
Date of Final Office Action: August 20, 2008	)	
Attorney Docket No.: PHDE020269US/PKRX200106	)	Cleveland, OH 44114 March 11, 2009

BRIEF ON APPEAL

I. STATEMENT OF REAL PARTY IN INTEREST (41.37(f))

The real party in interest for this appeal and the present application is Koninklijke Philips Electronics, N.V.

II. STATEMENT OF RELATED CASES (41.37(g))

None.

III. JURISDICTIONAL STATEMENT (41.37(h))

The Board has jurisdiction under 35 U.S.C. 134(a).

The Examiner mailed a final rejection on August 20, 2008, setting a three-month shortened statutory period for response.

The time for responding to the final rejection expired on November 20, 2008. Rule 134.

A notice of appeal with a two-month extension of time was filed on January 15, 2009.

The time for filing an appeal brief is two months after the filing of a notice of appeal. Bd.R. 41.37(c). The time for filing an appeal brief expires on Monday, March 16, 2009.

IV. TABLE OF CONTENTS (41.37(i))

V. TABLE OF AUTHORITIES (41.37(j))

None.

VI. STATUS OF AMENDMENTS (41.37(l))

The "Amendment After Final" (Request for Reconsideration) filed on October 20, 2008 was considered (entered). This Amendment did not seek to amend the claims.

A Second Amendment After Final accompanies this Appeal Brief in anticipation of potential *In re Bilski* 35 U.S.C. § 101 issues.

VII. GROUNDS OF REJECTION TO BE REVIEWED (41.37(m))

Whether claims 1-6 and 11-15 are "equivalent" (Advisory Action of November 26, 2008, last page, last line) in the sense of 35 U.S.C. § 102 to Shen ("Differential Volume Rendering: A Fast Volume Visualization Technique for Flow Anamation").

Whether claims 8 and 9 are patentable in the sense of 35 U.S.C. § 103 over Shen as modified by Brandl (US 6,450,962).

Whether claim 10 is patentable in the sense of 35 U.S.C. § 103 over Shen as modified by Goto (US 2004/0075658).

VIII. STATEMENT OF FACTS (41.37(n))

1. Shen generates a series of three-dimensional or volume data sets or images at temporally displaced intervals (Shen, pages 180-181, introduction).

2. To reduce the amount of data storage required and to reduce the time needed to generate two-dimensional images from the data, such as by ray casting, Shen proposes to subtract each volume or 3D image is subtracted from its preceding 3D volume or image to create a differential 3D volume image (Shen, page 181, first column, second full paragraph; page 181, second column, first full paragraph).

3. Shen calls for the creation of these differential volume images to be performed in a preprocessing step (Shen, page 182, column 1, lines 1-8).

4. Once the series of differential 3D images are generated, Shen renders or derives two-dimensional images interactively from the differential volume images using, for example, ray casting techniques (Shen, page 182, column 2, first full paragraph).

5. Shen describes a variety of ray casting techniques which can be utilized (Shen, page 182, column 2, first paragraph – page 184, first column, lines 1-15).

6. In a surface rendering technique, the first voxel with an intensity or value greater than a threshold is the relevant voxel (present application, page 8, line 32 – page 9, line 12; Figure 4c, Ray 15).

7. To determine the relevant values from a second volume image, claim 1 calls for determining the second volume values which are associated with the relevant first volume values or with voxels neighboring the relevant first voxel values (present application, claim 1, step d)).

8. The relevant second volume values rather than being determined statically based on a radius around the corresponding voxel in the second volume image, the corresponding voxels in the second volume image may be based on a motion model (present application, page 11, line 25 – page 12, line 5).

IX. ARGUMENT (41.37(o))

A. The Claims Are An Improvement Over and Not Equivalent to Shen

Shen generates a series of three-dimensional or volume data sets or images at temporally displaced intervals (Shen, pages 180-181, introduction). By way of example, in a high resolution CT scanner, each volume or 3D data set may be 1024x1024x1024 voxels which would yield about 0.5 mm resolution in a 20 inch field-of-view. Such a volume has on the order of 10^9 or 1,000,000,000 voxels. To reduce the amount of data storage required and to reduce the time needed to generate two-dimensional images from the data, such as by ray casting, Shen proposes to perform a preprocessing step in which each volume or 3D image is subtracted from its preceding 3D volume image to provide a differential 3D volume image (Shen, page 181, first column, second full paragraph; page 181, second column, first full paragraph). Thus, in the 1024x1024x1024 example, generating a single 3D difference image requires on the order of 1,000,000,000 subtraction operations. As is well-known, the gray scale values of CT data can be very finely differentiated. The gray scale value for each voxel can easily be resolved to 64 bits, 128 bits, 256 bits, etc. Accordingly, it is not surprising that Shen calls for the creation of these differential 3D images to be performed in a preprocessing step (Shen, page 182, column 1, lines 1-8).

Once the series of differential 3D images are generated, Shen renders or derives two-dimensional images interactively from the differential 3D images using, for example, ray casting techniques (Shen, page 182, column 2, first full paragraph). Because the subtraction process zeroed many of the voxels in the differential 3D images, the ray casting techniques can be performed relatively quickly.

Shen describes a variety of ray casting techniques which can be utilized (Shen, page 182, column 2, first paragraph – page 184, first column, lines 1-15). However, the various ray casting techniques are not pertinent to the issues on appeal. Both Shen and an exemplary embodiment of the present application use ray casting once they have obtained their 3D volume data sets or images. Ray casting is one example of how the first and second two-dimensional images can be derived in steps c) and f) of claim 1. Most any of the ray casting techniques or others can be used to derive the two-dimensional images once the volume data sets or images have been prepared. The difference between Shen and the present application resides in how the 3D volume data sets or images are prepared in advance of the ray casting or other technique for deriving the two-dimensional images.

Claim 1 calls for determining relevant first volume values in a first volume image which relevant first volume values are relevant to the visualization of the first volume image. When the two-dimensional

image is to be derived by ray casting, the relevant values are the values which contribute to the two-dimensional image. For example, in a surface rendering technique, the first voxel with an intensity or value greater than a threshold is the relevant voxel (present application, page 8, line 32 – page 9, line 12; Figure 4c, Ray 15). That is, the ray travels through the volume until it finds a voxel of the threshold value which may, for example, be indicative of the surface of the heart, a surface of a ventricle within a heart, or the like, depending on the gray scale level selected as the threshold.

To determine the relevant values from a second volume image, claim 1 calls for determining the second volume values which are associated with the relevant first volume values or with voxels neighboring the relevant first voxel values (present application, claim 1, step d)). That is, rather than storing the entire second 3D volume and rather than subtracting the first and second 3D volumes, the present application merely determines and stores the relevant second volume values, i.e., those values which are associated with or neighbor one of the stored first volume relevant values. For example, the second volume relative values may be determined as the values which neighbor each relevant first volume value within a preselected radius, e.g., three voxels. The exact number of voxels is based on *a priori* information or an estimation of the amount of the maximum magnitude of movement which

might be expected. The relevant second volume values rather than being determined statically based on a radius around the corresponding voxel in the second volume image, the corresponding voxels in the second volume image may be based on a motion model (present application, page 11, line 25 – page 12, line 5).

So now, in the second 3D volume data set or image of the present application, all of the data has effectively been removed except for the voxel values of the voxels associated with the relevant voxels of the first image data set. For example, if the voxels within a radius of three voxels are deemed relevant, then when ray casting is used to derive the two-dimensional images, the rays will be cast through about seven voxels. Thus, instead of having to analyze on the order of 1,000 voxels for each ray cast, only about a half-dozen or so voxels need to be or are available to be analyzed.

Thus, the stored second voxels with which the relevant second volume values are associated in step e) of claim 1 may have some similarities to the differential 3D volume image of Shen, it is not the same and it is obtained with 1,000,000,000 fewer subtraction steps, in the 1024x1024x1024 example.

It is submitted that saving on the order of 1,000,000,000 multi-bit subtractions is a substantial advantage over the Shen technique. Saving 1,000,000,000 subtraction operations expedites data processing time and

reduces hardware or software overhead. By eliminating the 1,000,000,000 subtraction operations, the preprocessing step in which they are performed can also be eliminated, enabling the two-dimensional images to be displayed substantially in real-time in the present application.

Accordingly, it is submitted that the claims of the present application are not the equivalent of Shen as asserted by the Examiner.

B. **Claims 1-7, 12, and 13 Are Not Anticipated By and Are Patentable Over Shen**

Claim 1 calls for storing first voxels of the first volume image with which the relevant first volume values are associated. Then, in step d), claim 1 calls for determining relevant second volume values of the second volume image from second volume values which are associated with the stored first voxels or with voxels neighboring the stored first voxels. The second voxels with which the relevant second volume values are associated are stored and it is from these stored second voxels that the second two-dimensional image is derived. By determining the second voxels based on the first voxels with the relevant first volume values, the vast amount of calculations necessary for Shen to subtract the two adjacent 3D volume images are eliminated and processing is expedited.

Regarding section d), the Examiner refers the applicant to Shen, pages 182-183: "pixel position calculation". This section is not related to the generation of the 3D volume image into which the rays are cast. Rather, this section of Shen relates to various known ray casting techniques. When one casts a ray into a 3D grid, particularly at a non-orthogonal angle, as the rays pass through the grid of cubic voxels, each ray does not pass through the exact center of every voxel which it strikes. As described in Shen, each voxel is defined by one of the data values on each of its eight corners. When the ray strikes a voxel, one determines what value the struck voxel contributes based on the values at its eight corners. Shen makes this determination based on a weighted interpolation of the data values at each of the eight corners. In the zero order interpolation scheme referenced by the Examiner, rather than a weighted average of the values at the eight corners, only the data value which is nearest to the ray is sampled. This approximation saves the data processing to perform the interpolation step.

It must be emphasized that the zero order interpolation scheme is a part of the ray casting. Ray casting, in the present application, is one example of the process performed in steps c) and f) of the present application to derive a two-dimensional image from the stored voxels of the 3D volume image. The ray casting interpolation scheme cited by the Examiner does not correspond to and is not relevant to step d) of claim 1.

Claim 1 also calls for determining the relevant first volume values and storing the relevant first volume values. It is from the stored relevant first volume values that the first two-dimensional image is derived. By contrast, Shen subtracts two consecutive 3D volumes and stores the differential 3D volume image. It is from this differential 3D volume image that the two-dimensional image of Shen is derived. Thus, claim 1 derives the first two-dimensional image based only on the stored first voxels with which the relevant first volume values are associated. This simplifies a ray casting operation or other two dimensional image derivation step by reducing the number of voxels through which the ray is cast.

Accordingly, it is submitted that **claim 1 and claims 2-6, 12, and 13 dependent therefrom** are not anticipated by Shen.

C. **Claim 2 is Not Anticipated by Shen**

Claim 2 calls for defining the neighboring voxels based on a motion model. By contrast, Shen subtracts two consecutive 3D volume images to determine a differential 3D image. Shen uses simple subtraction between two 3D volume images to determine the difference image. Shen does not use nor make any suggestion of how one might use a motion model to perform this subtraction.

Accordingly, it is submitted that claim 2 is not anticipated by Shen.

D. **Claim 3 is Not Anticipated by Shen**

Claim 3 calls for defining voxels from regions surrounding the stored first voxels as neighboring voxels. Shen does not define any voxels as neighboring, much less define voxels as neighboring based on surrounding regions or proximity to stored voxels of the prior 3D image. Rather, Shen merely subtracts two consecutive 3D images to obtain a differential 3D image. When the two consecutive 3D images are subtracted, the voxels of the difference 3D image may or may not be neighboring to voxels of one of the other images. The difference is whatever the difference is without regard to proximity of stored voxels of a first image. Moreover, Shen has no stored first voxels as defined in claim 1. The subtraction in Shen is between two full consecutive 3D volume images.

Accordingly, it is submitted that **claim 3 and claims 4 and 5 dependent therefrom** are not anticipated by Shen.

E. **Claim 4 is Not Anticipated by Shen**

Claim 4 calls for at least one of the shape and magnitude of the surrounding regions to be adjustable. The Examiner again refers the

application to the interpolation during ray casting in Shen, which is not relevant at this point in claim 1. Rather, the ray casting is an example of step f) in which the two-dimensional representation is derived. In Shen, the differential 3D image is not disclosed as having adjustable regions surrounding the stored pixels with the relevant prior volume values. The Shen subtracting operation gives a difference which is a fixed mathematical operation which makes no suggestion of a shape or magnitude which is adjustable.

Accordingly, it is submitted that **claim 4** is not anticipated by Shen.

F. **Claim 5 is Not Anticipated by Shen**

Claim 5 calls for the surrounding region to comprise all voxels positioned no further than a given geometric distance from a stored first voxel. By contrast, Shen subtracts two consecutive 3D images to create a differential 3D image. The differential image is defined by the subtraction operation and not by any given geometrical distance from a stored voxel.

The Examiner refers the applicant to the portions of Shen relating to interpolation during ray casting which is how the two-dimensional image is derived and which does not relate to step d) which claim 5 further refines.

Accordingly, it is submitted that claim 5 is not anticipated by Shen.

G. **Claim 6 is Not Anticipated by Shen**

Claim 1 calls for determining the relevant first volume values of the first volume image and storing first voxels with which the relevant first volume image values are associated. **Claim 6** refines this storing step by calling for the first voxels to be combined in blocks. Because the voxels are stored in blocks, neighboring voxels which may not themselves have been deemed relevant are stored in order to shape the blocks. Thus, claim 6 indirectly relates to the selection of neighboring voxels. The Final Rejection appears to be confusing this block issue with the cubic voxels which are found in volume images.

Accordingly, it is submitted that **claim 6** is not anticipated by Shen.

H. **Claim 13 is Not Anticipated by Shen**

Claim 13 calls for determining the relevant first volume values of the first volume image to be based on imaging direction. The subtraction of consecutive 3D volume images in Shen is not based on imaging direction.

The Final Rejection refers the applicant to page 181, column 1, lines 3-16, which relate to the ray casting, which corresponds to steps c) and f) in which the two-dimensional images are derived. While ray casting is directionally dependent based on the direction of the rays, claim 13 is further refines step a), not step c) or step f).

Accordingly, it is submitted that **claim 13** is not anticipated by Shen.

I. Claim 11 is Not Anticipated by Shen

Claim 11 calls for determining relevant first volume values of a first volume image and deriving a first two-dimensional image from the first voxels. By contrast, Shen subtracts two consecutive 3D volume images to generate a differential 3D image from which the two-dimensional image is derived by ray casting. Thus, in Shen, the two-dimensional image is derived based on a difference between first and second 3D volume images and not based on relevant first volume values of a first volume image.

Claim 11 calls for determining relevant second volume values of a second image, which second volume values are associated with the first voxels or with voxels neighboring the first voxels. By contrast, Shen subtracts second and third 3D volume images to generate a second differential image from which the second two-dimensional image is

derived. Shen does not derive the second two-dimensional image from second volume values of the second 3D image which are associated with the first voxels or with voxels neighboring the first voxels which were determined based on the first volume or 3D image.

As explained above, in the 1024x1024x1024 example, the present technique of determining relevant second volume values which are associated with the first voxels or with the voxels neighboring the first voxels saves on the order of 1,000,000,000 subtraction operations.

Accordingly, it is submitted that **claim 11** is not anticipated by Shen.

J. Claims 8-10 and 14 Are Not Anticipated by Shen Nor Rendered Unpatentable by Shen and Brandl

Claim 14 calls for an image processor for determining first volume values of a first image volume which are relevant to visualization of the first volume image, causing first voxels associated with the relevant first volume values to be stored in memory, and deriving a first two-dimensional image from the stored first voxels of the first volume image. By distinction, to generate a first two-dimensional image, Shen subtracts first and second 3D volume images to obtain a first 3D differential image. It is from this first 3D differential image that the first two-dimensional image of Shen is derived. Thus, Shen derives the first

two-dimensional image based on a difference between first and second 3D volume images and not based on stored first voxels with which relevant first volume values determined from the first volume image are associated.

Further, claim 14 calls for determining second volume values of a second volume image which are relevant to visualization of the second volume image from volume values associated with the first stored voxels or with voxels neighboring the stored first voxels, causing second voxels with which the relevant second volume voxels are associated to be stored, and deriving a second two-dimensional image from the stored second voxels of the second volume image. By contrast, Shen derives a second 3D image by subtracting second and third 3D images to generate a second differential 3D image. It is from this second differential image that the second two-dimensional image of Shen is derived. Subtracting consecutive 3D images does not determine second volume values of the second image which are relevant to visualization of the second volume, much less determine such second volume values based on volume values associated with stored first voxels or with voxels neighboring the stored first voxels. The second two-dimensional image of Shen is based on the difference between the second and third 3D or volume images, not based on portions of the second 3D or volume image identified based on relevant voxels of the first 3D or volume image.

Because Shen operates in a materially different way which includes an extremely computationally intensive subtraction of pairs of consecutive volume images rather than in the simple claimed technique which eliminates these subtraction operations, it is submitted that claim 14 represents an advantageous advancement over Shen.

Accordingly, it is submitted that **claim 14 and claims 15 and 8-10 dependent therefrom** distinguish patentably and unobviously over the references of record.

K. CONCLUSION

For all of the reasons discussed above, it is respectfully submitted that claims 1-6 and 8-15 are not anticipated by and distinguish patentably over the references of record. An early reversal of the rejections of all claims is requested.

Respectfully submitted,

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APPENDIX

X. CLAIMS SECTION (41.37(p)) (Without the "Second Amendment After Final" Entered)

1. (Rejected) A method for visualizing a sequence of volume images of a moving object, which method comprises the steps of:

a) determining relevant first volume values of a first volume image, which are relevant to visualization of the first volume image, from first volume values of said first volume image;

b) storing first voxels with which the relevant first volume values are associated;

c) deriving a first two-dimensional image from the stored first voxels of the first volume image;

d) determining relevant second volume values of a second volume image, which are relevant to visualization of the second volume image, from second volume values which are associated with the stored first voxels or with voxels neighboring said stored first voxels;

e) storing second voxels with which the relevant second volume values are associated; and

f) deriving a second two-dimensional image from the stored second voxels of the second volume image.

2. (Rejected) The method as claimed in claim 1, in which the neighboring voxels are defined by a motion model of the moving object .

3. (Rejected) The method as claimed in claim 1, in which all voxels from regions surrounding the stored first voxels are defined as neighboring voxels.

4. (Rejected) The method as claimed in claim 3, in which at least one of a shape and a magnitude of the surrounding regions is adjustable.

5. (Rejected) The method as claimed in claim 3, in which a surrounding region comprises all voxels positioned no further than a given geometrical distance from a stored first voxel.

6. (Rejected) The method as claimed in claim 1, in which the first voxels of the first volume image are combined in blocks for storage, each block being stored when a first volume value associated with at least one first voxel in the block is relevant for the visualization of the first volume image, the visualization of the second volume image being derived from the second volume values which are associated with the first voxels in the stored blocks or in blocks neighboring the stored blocks.

7. (Cancelled)

8. (Rejected) The apparatus as claimed in claim 14, further comprising:

an acquisition unit for acquiring the first and second volume images.

9. (Rejected) The apparatus as claimed in claim 8, wherein the apparatus is an ultrasound apparatus, and the acquisition unit comprises a sonography applicator.

10. (Rejected) The apparatus as claimed in claim 8, wherein the apparatus is a CT apparatus, and the acquisition unit comprises an X-ray source and an X-ray detector.

11. (Rejected) A computer readable medium having stored thereon a program executable by a computer for visualizing a sequence of volume images of a moving object, the computer readable medium comprising:

a first determining code segment for determining relevant first volume values of a first volume image, which are relevant to visualization of the first volume image, from first volume values of the first volume image;

a first deriving code segment for deriving a first two-dimensional image from first voxels corresponding to the relevant first volume values of the first volume image;

a second determining code segment for determining relevant second volume values of a second volume image, which are relevant to visualization of the second volume image, from second volume values which are associated with the first voxels or with voxels neighboring said first voxels; and

a second deriving code segment for deriving a second two-dimensional image from second voxels corresponding to the relevant second volume values of the second volume image.

12. (Rejected) The method as claimed in claim 1, further comprising the step of:

repeating the steps d) to f) to derive further two-dimensional images from subsequent volume images.

13. (Rejected) The method as claimed in claim 1, wherein determining the relevant first volume values of the first volume image, which are relevant for the visualization of the first volume image, is based on an imaging direction.

14. (Rejected) An apparatus for visualizing a sequence of volume images, the apparatus comprising:

a data input for inputting volume images of a moving object;

a memory for storing voxels associated with volume values of the volume images; and

an image processor for determining first volume values of a first volume image which are relevant to visualization of the first volume image, causing first voxels with which the relevant first volume values are associated to be stored in the memory, deriving a first two-dimensional image from the stored first voxels of the first volume image, determining second volume values of a second volume image which are relevant to visualization of the second volume image from volume values associated with stored first voxels or with voxels neighboring the stored first voxels, causing second voxels with which the relevant second volume values are associated to be stored in the memory, and deriving a second two-dimensional image from the stored second voxels of the second volume image.

15. (Rejected) The apparatus of claim 14, further comprising:

a monitor for consecutively displaying the first two-dimensional image and the second two-dimensional image.

XI. CLAIMS SECTION (41.37(p)) (With the "Second Amendment After Final" Entered)

1. (Rejected) A method for visualizing a sequence of volume images of a moving object, which method comprises the steps of:

a) determining relevant first volume values of a first volume image, which are relevant to visualization of the first volume image, from first volume values of said first volume image;

b) storing first voxels with which the relevant first volume values are associated;

c) deriving a first two-dimensional image from the stored first voxels of the first volume image;

d) determining relevant second volume values of a second volume image, which are relevant to visualization of the second volume image, from second volume values which are associated with the stored first voxels or with voxels neighboring said stored first voxels;

e) storing second voxels with which the relevant second volume values are associated;

f) deriving a second two-dimensional image from the stored second voxels of the second volume image; and

g) at least one of displaying and storing at least one of the first and second two-dimensional images.

2. (Rejected) The method as claimed in claim 1, in which the neighboring voxels are defined by a motion model of the moving object .

3. (Rejected) The method as claimed in claim 1, in which all voxels from regions surrounding the stored first voxels are defined as neighboring voxels.

4. (Rejected) The method as claimed in claim 3, in which at least one of a shape and a magnitude of the surrounding regions is adjustable.

5. (Rejected) The method as claimed in claim 3, in which a surrounding region comprises all voxels positioned no further than a given geometrical distance from a stored first voxel.

6. (Rejected) The method as claimed in claim 1, in which the first voxels of the first volume image are combined in blocks for storage, each block being stored when a first volume value associated with at least one first voxel in the block is relevant for the visualization of the first volume image, the visualization of the second volume image being derived from the second volume values which are associated with the first voxels in the stored blocks or in blocks neighboring the stored blocks.

7. (Cancelled)

8. (Rejected) The apparatus as claimed in claim 14, further comprising:

an acquisition unit for acquiring the first and second volume images.

9. (Rejected) The apparatus as claimed in claim 8, wherein the apparatus is an ultrasound apparatus, and the acquisition unit comprises a sonography applicator.

10. (Rejected) The apparatus as claimed in claim 8, wherein the apparatus is a CT apparatus, and the acquisition unit comprises an X-ray source and an X-ray detector.

11. (Rejected) A computer readable medium having stored thereon a program executable by a computer for visualizing a sequence of volume images of a moving object, the computer readable medium comprising:

a first determining code segment for determining relevant first volume values of a first volume image, which are relevant to visualization of the first volume image, from first volume values of the first volume image;

a first deriving code segment for deriving a first two-dimensional image from first voxels corresponding to the relevant first volume values of the first volume image;

a second determining code segment for determining relevant second volume values of a second volume image, which are relevant to visualization of the second volume image, from second volume values which are associated with the first voxels or with voxels neighboring said first voxels; and

a second deriving code segment for deriving a second two-dimensional image from second voxels corresponding to the relevant second volume values of the second volume image.

12. (Rejected) The method as claimed in claim 1, further comprising the step of:

repeating the steps d) to f) to derive further two-dimensional images from subsequent volume images.

13. (Rejected) The method as claimed in claim 1, wherein determining the relevant first volume values of the first volume image, which are relevant for the visualization of the first volume image, is based on an imaging direction.

14. (Rejected) An apparatus for visualizing a sequence of volume images, the apparatus comprising:

a data input for inputting volume images of a moving object;

a memory for storing voxels associated with volume values of the volume images; and

an image processor for determining first volume values of a first volume image which are relevant to visualization of the first volume image, causing first voxels with which the relevant first volume values are associated to be stored in the memory, deriving a first two-dimensional image from the stored first voxels of the first volume image, determining second volume values of a second volume image which are relevant to visualization of the second volume image from volume values associated with stored first voxels or with voxels neighboring the stored first voxels, causing second voxels with which the relevant second volume values are associated to be stored in the memory, and deriving a second two-dimensional image from the stored second voxels of the second volume image.

15. (Rejected) The apparatus of claim 14, further comprising:

a monitor for consecutively displaying the first two-dimensional image and the second two-dimensional image.

APPENDIX (Continued)

XII. CLAIM SUPPORT AND DRAWING ANALYSIS SECTION (41.37(r))

1. A method for visualizing a sequence of volume images of a moving object **{p. 1, l. 19-20}**, which method comprises the steps of:

a) determining relevant first volume values of a first volume image **{B2}**, which are relevant to visualization of the first volume image, from first volume values of said first volume image; **{p. 1, l. 21-22; p. 5, l. 26-34; step 21}**

b) storing first voxels with which the relevant first volume values are associated; **{p. 1, l. 23; p. 5, l. 27-31}**

c) deriving a first two-dimensional image **{I2}** from the stored first voxels of the first volume image; **{p. 1, l. 24; p. 8, l. 8-31; also p. 8, l. 32 – p. 10, l. 25}**

d) determining relevant second volume values of a second volume image **{B3}**, which are relevant to visualization of the second volume image, from second volume values which are associated with the stored first voxels or with voxels neighboring said stored first voxels; **{p. 1, l. 25-27; p. 3, l. 3-15; p. 6, l. 1-10; p. 12, l. 14-28; p. 11, l. 16 – p. 12, l. 13}**

e) storing second voxels with which the relevant second volume values are associated; **{p. 1, l. 28}**

f) deriving a second two-dimensional image **{I3}** from the stored second voxels of the second volume image; **{p. 1, l. 29; p. 8, l. 8 – p. 10, l. 25}** and

g) at least one of displaying and storing at least one of the first and second two-dimensional images. **{p. 5, l. 22-29}**

2. The method as claimed in claim 1, in which the neighboring voxels are defined by a motion model of the moving object. **{p. 3, l. 25 – p. 4, l. 2; p. 11, l. 25 – p. 12, l. 13}**

3. The method as claimed in claim 1, in which all voxels from regions surrounding the stored first voxels are defined as neighboring voxels. **{p. 11, l. 16-24}**

4. The method as claimed in claim 3, in which at least one of a shape and a magnitude of the surrounding regions is adjustable. **{p. 11, l. 16-24; p. 16, l. 20-21}**

5. The method as claimed in claim 3, in which a surrounding region comprises all voxels positioned no further than a given geometrical distance from a stored first voxel. **{p. 11, l. 16-24}**

6. The method as claimed in claim 1, in which the first voxels of the first volume image are combined in blocks for storage, each block being stored when a first volume value associated with at least one first voxel in the block is relevant for the visualization of the first volume image, the visualization of the second volume image being derived from the second volume values which are associated with the first voxels in the stored blocks or in blocks neighboring the stored blocks. **{p. 13, l. 4-27}**

8. The apparatus as claimed in claim 14, further comprising:

an acquisition unit for acquiring the first and second volume images. **{p. 4, l. 26-30}**

9. The apparatus as claimed in claim 8, wherein the apparatus is an ultrasound apparatus, and the acquisition unit comprises a sonography applicator. **{32; Fig. 3; p. 6, l. 19 – p. 7, l. 24}**

10. The apparatus as claimed in claim 8, wherein the apparatus is a CT apparatus, and the acquisition unit comprises an X-ray source and an X-ray detector. **{16; Fig. 5; p. 14, l. 1 – p. 15, l. 23}**

11. A computer readable medium having stored thereon a program executable by a computer for visualizing a sequence of volume images of a moving object, **{p. 5, l. 1-3; p 7, l. 15-24; p. 17, l. 33-34}** the computer readable medium comprising:

a first determining code segment for determining relevant first volume values of a first volume image, which are relevant to visualization of the first volume image, from first volume values of the first volume image; **{p. 1, l. 21-22; p. 5, l. 26-34; step 21}**

a first deriving code segment for deriving a first two-dimensional image from first voxels corresponding to the relevant first volume values of the first volume image; **{p. 1, l. 24; p. 8, l. 8-31; also p. 8, l. 32 – p. 10, l. 25}**

a second determining code segment for determining relevant second volume values of a second volume image, which are relevant to visualization of the second volume image, from second volume values which are associated with the first voxels or with voxels neighboring said first voxels; and **{p. 1, l. 25-27; p. 3, l. 3-15; p. 6, l. 1-10; p. 12, l. 14-28; p. 11, l. 16 – p. 12, l. 13}**

a second deriving code segment for deriving a second two-dimensional image from second voxels corresponding to the relevant second volume values of the second volume image. **{p. 1, l. 29; p. 8, l. 8 – p. 10, l. 25}**

12. The method as claimed in claim 1, further comprising the step of:

repeating the steps d) to f) to derive further two-dimensional images from subsequent volume images. **{p. 2, l. 1; p. 3, l. 16-22}**

13. The method as claimed in claim 1, wherein determining the relevant first volume values of the first volume image, which are relevant for the visualization of the first volume image, is based on an imaging direction. **{p. 8, l. 12-15}**

14. An apparatus for visualizing a sequence of volume images **{p. 4, l. 26-31}**, the apparatus comprising:

a data input **{16, 32}** for inputting volume images of a moving object; **{Fig. 3, 5; p. 6, l. 19 – p. 7, l. 24; p. 14, l. 1 – p. 15, l. 23}**

a memory **{F1; 38, 10}** for storing voxels associated with volume values of the volume images; and **{p. 1, l. 26-29; p. 7, l. 8-14; p. 14, l. 20-30; Fig. 1, 3, 5}**

an image processor **{37, 102}** for determining first volume values of a first volume image which are relevant to visualization of the first volume image, causing first voxels with which the relevant first volume values are associated to be stored in the memory, deriving a first two-dimensional image from the stored first voxels of the first volume image, determining second volume values of a second volume image which are relevant to visualization of the second volume image from

volume values associated with stored first voxels or with voxels neighboring the stored first voxels, causing second voxels with which the relevant second volume values are associated to be stored in the memory, and deriving a second two-dimensional image from the stored second voxels of the second volume image. **{Fig. 3, 5; p. 7, l. 25 – p. 8, l. 12; p. 14, l. 20 – p. 15, l. 23; p. 1, l. 21-22; p. 5, l. 26-34; step 21; p. 1, l. 24; p. 8, l. 8-31; also p. 8, l. 32 – p. 10, l. 25}**

15. The apparatus of claim 14, further comprising:

a monitor **{34; 11}** for consecutively displaying the first two-dimensional image and the second two-dimensional image. **{p. 7, l. 7-24; p. 14, l. 27-28}**

APPENDIX (Continued)

XIII. MEANS OR STEP PLUS FUNCTION ANALYSIS SECTION (41.37(s))

1. A method for visualizing a sequence of volume images of a moving object **{p. 1, l. 19-20}**, which method comprises the steps of:

a) determining relevant first volume values of a first volume image **{B2}**, which are relevant to visualization of the first volume image, from first volume values of said first volume image; **{p. 1, l. 21-22; p. 5, l. 26-34; step 21}**

b) storing first voxels with which the relevant first volume values are associated; **{p. 1, l. 23; p. 5, l. 27-31}**

c) deriving a first two-dimensional image **{I2}** from the stored first voxels of the first volume image; **{p. 1, l. 24; p. 8, l. 8-31; also p. 8, l. 32 – p. 10, l. 25}**

d) determining relevant second volume values of a second volume image **{B3}**, which are relevant to visualization of the second volume image, from second volume values which are associated with the stored first voxels or with voxels neighboring said stored first voxels; **{p. 1, l. 25-27; p. 3, l. 3-15; p. 6, l. 1-10; p. 12, l. 14-28; p. 11, l. 16 – p. 12, l. 13}**

e) storing second voxels with which the relevant second volume values are associated; **{p. 1, l. 28}**

f) deriving a second two-dimensional image **{I3}** from the stored second voxels of the second volume image; **{p. 1, l. 29; p. 8, l. 8 – p. 10, l. 25}** and

g) at least one of displaying and storing at least one of the first and second two-dimensional images. **{p. 5, l. 22-29}**

2. The method as claimed in claim 1, in which the neighboring voxels are defined by a motion model of the moving object. **{p. 3, l. 25 – p. 4, l. 2; p. 11, l. 25 – p. 12, l. 13}**

3. The method as claimed in claim 1, in which all voxels from regions surrounding the stored first voxels are defined as neighboring voxels. **{p. 11, l. 16-24}**

4. The method as claimed in claim 3, in which at least one of a shape and a magnitude of the surrounding regions is adjustable. **{p. 11, l. 16-24; p. 16, l. 20-21}**

5. The method as claimed in claim 3, in which a surrounding region comprises all voxels positioned no further than a given geometrical distance from a stored first voxel. **{p. 11, l. 16-24}**

6. The method as claimed in claim 1, in which the first voxels of the first volume image are combined in blocks for storage, each block being stored when a first volume value associated with at least one first voxel in the block is relevant for the visualization of the first volume image, the visualization of the second volume image being derived from the second volume values which are associated with the first voxels in the stored blocks or in blocks neighboring the stored blocks. **{p. 13, l. 4-27}**

8. The apparatus as claimed in claim 14, further comprising:

an acquisition unit for acquiring the first and second volume images. **{p. 4, l. 26-30}**

9. The apparatus as claimed in claim 8, wherein the apparatus is an ultrasound apparatus, and the acquisition unit comprises a sonography applicator. **{32; Fig. 3; p. 6, l. 19 – p. 7, l. 24}**

10. The apparatus as claimed in claim 8, wherein the apparatus is a CT apparatus, and the acquisition unit comprises an X-ray source and an X-ray detector. **{16; Fig. 5; p. 14, l. 1 – p. 15, l. 23}**

11. A computer readable medium having stored thereon a program executable by a computer for visualizing a sequence of volume images of a moving object, **{p. 5, l. 1-3; p 7, l. 15-24; p. 17, l. 33-34}** the computer readable medium comprising:

a first determining code segment for determining relevant first volume values of a first volume image, which are relevant to visualization of the first volume image, from first volume values of the first volume image; **{p. 1, l. 21-22; p. 5, l. 26-34; step 21}**

a first deriving code segment for deriving a first two-dimensional image from first voxels corresponding to the relevant first volume values of the first volume image; **{p. 1, l. 24; p. 8, l. 8-31; also p. 8, l. 32 – p. 10, l. 25}**

a second determining code segment for determining relevant second volume values of a second volume image, which are relevant to visualization of the second volume image, from second volume values which are associated with the first voxels or with voxels neighboring said first voxels; and **{p. 1, l. 25-27; p. 3, l. 3-15; p. 6, l. 1-10; p. 12, l. 14-28; p. 11, l. 16 – p. 12, l. 13}**

a second deriving code segment for deriving a second two-dimensional image from second voxels corresponding to the relevant second volume values of the second volume image. **{p. 1, l. 29; p. 8, l. 8 – p. 10, l. 25}**

12. The method as claimed in claim 1, further comprising the step of:

repeating the steps d) to f) to derive further two-dimensional images from subsequent volume images. **{p. 2, l. 1; p. 3, l. 16-22}**

13. The method as claimed in claim 1, wherein determining the relevant first volume values of the first volume image, which are relevant for the visualization of the first volume image, is based on an imaging direction. **{p. 8, l. 12-15}**

14. An apparatus for visualizing a sequence of volume images **{p. 4, l. 26-31}**, the apparatus comprising:

a data input **{16, 32}** for inputting volume images of a moving object; **{Fig. 3, 5; p. 6, l. 19 – p. 7, l. 24; p. 14, l. 1 – p. 15, l. 23}**

a memory **{F1; 38, 10}** for storing voxels associated with volume values of the volume images; and **{p. 1, l. 26-29; p. 7, l. 8-14; p. 14, l. 20-30; Fig. 1, 3, 5}**

an image processor **{37, 102}** for determining first volume values of a first volume image which are relevant to visualization of the first volume image, causing first voxels with which the relevant first volume values are associated to be stored in the memory, deriving a first two-dimensional image from the stored first voxels of the first volume image, determining second volume values of a second volume image which are relevant to visualization of the second volume image from

volume values associated with stored first voxels or with voxels neighboring the stored first voxels, causing second voxels with which the relevant second volume values are associated to be stored in the memory, and deriving a second two-dimensional image from the stored second voxels of the second volume image. **{Fig. 3, 5; p. 7, l. 25 – p. 8, l. 12; p. 14, l. 20 – p. 15, l. 23; p. 1, l. 21-22; p. 5, l. 26-34; step 21; p. 1, l. 24; p. 8, l. 8-31; also p. 8, l. 32 – p. 10, l. 25}**

15. The apparatus of claim 14, further comprising:

a monitor **{34; 11}** for consecutively displaying the first two-dimensional image and the second two-dimensional image. **{p. 7, l. 7-24; p. 14, l. 27-28}**

APPENDIX (Continued)

XIV. EVIDENCE SECTION (41.37(t))

Not applicable.

APPENDIX (Continued)

XV. RELATED CASES SECTION (41.37(u))

None.